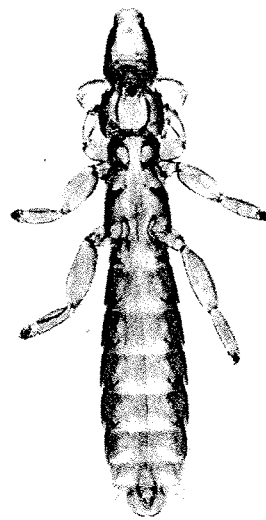


Extinction or 'co-extinction' rates?

SIR — Defining precisely when a species of bird or mammal has become extinct is notoriously difficult¹. The task is even more challenging for smaller organisms. To date only 61 species of insect are known to have become extinct since 1600 (ref. 2), yet there are about 10^6 – 10^7 species in this group^{3–5}. Smith *et al.* attempted to overcome the problem of measuring extinctions by using changes in the threatened status of species to provide new estimates of extinction rates⁶. The

fleas sometimes less so⁸. In both cases there are many insects restricted to single species of host, and as a host species becomes extinct, so does one or more species of parasite. Many will have shed a tear for the passing of the last passenger pigeon in 1914 (ref. 2) but until now the similar demise of at least two species of passenger pigeon louse (*Columbicola extinctus* Malcomson and *Campanulotes defectus* Tendeiro) has been ignored (see figure). How many species of lice and fleas



Left, the passenger pigeon *Ectopistes migratorius* (Linnaeus), from ref. 9 (NHM picture library). Above, passenger pigeon louse *C. extinctus* Malcomson (P. York/NHM).

measures they used suggest that the characteristic extinction time for half the species of birds and mammals is 200–300 years, and that for invertebrates such as molluscs is 60,000 years. There were insufficient data to provide a similar estimate for insects.

We believe that at least one group of insects, lice (Phthiraptera), and possibly another, fleas (Siphonaptera), may have a similar extinction rate to mammals and birds. Lice are extremely host-specific⁷,

have become extinct since 1600? In addition, how many internal parasites, both multicellular and protist, have vanished with their hosts?

This process of 'co-extinction' is problematic. While zoos concentrate increasingly on the conservation of threatened mammals and birds, the plight of the lice and fleas on these animals is ignored. Indeed, attempts are often made to sanitize the threatened vertebrates, and who can say whether this process causes more insect extinctions? Perhaps more fundamentally, these examples of co-extinction result from close co-evolution⁷, which itself can be viewed as one extreme of a continuum of species associations. In any ecosystem, extinction of one keystone species may lead to the loss of many others. Inevitably, lists of species extinctions and threatened species fail to take this into account.

Those who would not consider a louse to be of the same value as a bird raise an important ethical issue. Most people con-

sider the value of insects, either positive or negative (with perhaps the exception of butterflies), solely in terms of their contribution to ecosystems and their direct or indirect effect on humans. When discussing conservation priorities and practices, we need to examine these values rather than simply condemning portions of the animal kingdom to extinction without thought. There may be conflicts in conservation needs, forcing us to bid farewell to the gorilla louse or the lice of the Californian condor while retaining their hosts. If so, we should do so in the full knowledge of what is being lost.

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Hormone signal response system

SIR — A property of signal-response systems in general, and of G-protein-coupled receptors in particular, is that prolonged stimulation often results in reduced responsiveness to further challenge by the same stimulus. Receptor desensitization in humans is responsible for habituation to light, odours, chemical stimulants and narcotics, and is a factor that limits the efficacy of many therapeutic agents. As described for the β -adrenergic receptors, desensitization most certainly includes rapid receptor phosphorylation at cytoplasmic domains of the protein (for example by cyclic AMP-dependent protein kinase, PKA) and uncoupling from the G protein^{1,2}.

Namba *et al.*³ describe four alternatively spliced receptor isoforms of the prostaglandin E receptor, each having distinct second-messenger signalling properties. Data presented in their paper suggest another important functional difference between two of the receptor variants with regard to desensitization. Both the EP3B and EP3C isoforms were shown to mediate cAMP accumulation in transfected CHO cells, although EP3B had a significantly lower EC_{50} for the agonist. In cells pretreated with forskolin (which elevates cAMP production), however, this order of activity is reversed. The molecular basis for this change could result from differences in receptor desensitization. EP3B has nine Ser/Thr residues in the C-terminal 'tail' domain, at least one of which represents a potential PKA recognition site⁴, and may therefore be

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